Package 'raceland'

July 30, 2020

Title Pattern-Based Zoneless Method for Analysis and Visualization of
Racial Topography

Version 1.1.0

Description Implements a computational framework for a pattern-based,
zoneless analysis, and visualization of (ethno)racial topography
(Dmowska, Stepinski, and Nowosad (2020) <doi:10.1016/j.apgeog.2020.102239>).
It is a reimagined
approach for analyzing residential segregation and racial diversity based on
the concept of 'landscape' used in the domain of landscape ecology.

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Encoding UTF-8

LazyData true

RoxygenNote 7.1.1

Depends R (>= 3.5)

LinkingTo Rcpp, comat (>= 0.7.0), RcppArmadillo

Imports fasterize, methods, plotwidgets, raster, rgdal, sf, Rcpp,
comat

Suggests dplyr, pbapply, testthat (>= 2.1.0), knitr, rmarkdown,
RColorBrewer, covr

VignetteBuilder knitr

SystemRequirements C++11

URL https://nowosad.github.io/raceland/

BugReports https://github.com/Nowosad/raceland/issues

NeedsCompilation yes

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R topics documented:

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calculate_metrics   *Calculate Metrics*

Description

Calculates exposure matrix and quantifies it by calculating four IT-derived matrics: entropy (ent), joint entropy (joinent), conditional entropy (condent) and mutual information (mutinf). Entropy is associated with measuring racial diversity and mutual information is associated with measuring racial segregation.

Usage

```
calculate_metrics(
  x,
  w,
  neighbourhood = 4,
  fun,
  size = NULL,
  shift = NULL,
  na_action = "replace",
  base = "log2",
  ordered = TRUE,
  threshold = 0.5
)
```

Arguments

x	RasterStack with realizations
w	RasterStack with local densities
neighbourhood	The number of directions in which cell adjacencies are considered as neighbours: 4 (rook's case), 8 (queen's case). The default is 4.

fun	Function to calculate values from adjacent cells to contribute to exposure matrix, *"mean"* - calculate average values of local population densities from adjacent cells, *"geometric_mean"* - calculate geometric mean values of local population densities from adjacent cells, or *"focal"* assign value from the focal cell
size	Expressed in the numbers of cells, is a length of the side of a square-shaped block of cells. It defines the extent of a local pattern. If size=NULL calculations are performed for a whole area
shift	Defines the shift between adjacent squares of cells along with the N-S and W-E directions. It describes the density (resolution) of the output grid. The resolution of the output map will be reduced to the original resolution multiplied by the shift. If shift=size the input map will be divided into a grid of non-overlapping square windows. Each square window defines the extent of a local pattern. If shift < size - results in the grid of overlapping square windows.
na_action	Decides on how to behave in the presence of missing values in w. Possible options are *"replace"*, *"omit"*, *"keep"*. The default, *"replace"*, replaces missing values with 0, *"omit"* does not use cells with missing values, and *"keep"* keeps missing values.
base	The unit in which entropy is measured. The default is "log2", which compute entropy in "bits". *"log"* and *"log10"* can be also used
ordered	The type of pairs considered. Either ordered (TRUE) or unordered (FALSE). The default is TRUE
threshold	The share of NA cells to allow metrics calculation in a square-shaped window

Value

a data.frame

Examples

```
library(raster)
x = create_realizations(race_raster, n = 5)
w = create_densities(x, race_raster, window_size = 10)

#1
df = calculate_metrics(x, w, neighbourhood = 4, fun = "mean")

#2
df2 = calculate_metrics(x, w, neighbourhood = 4, fun = "mean", size = 10, threshold = 0.5)
my_grid = create_grid(x, size = 10)

df3 = dplyr::filter(df2, realization == 2)
result = dplyr::left_join(my_grid, df2, by = c("row", "col"))
plot(result)
```

---

create_densities *Create Densities*

Description

Calculate local densities of subpopulations (race-specific local densities)

Usage

```
create_densities(x, y, window_size)
```

Arguments

x	RasterStack with realizations
y	RasterStack with shares of subpopulations
window_size	Size, expressed in the number of cells, of a square-shaped local window for which local densities will be calculated; it is recommended to use the small window_size, i.e., 10

Value

a RasterStack containing n local densities. Local density layer is calculated for each realization

Examples

```
library(raster)
real_rasters = create_realizations(race_raster, n = 5)
plot(real_rasters)
dens_raster = create_densities(real_rasters, race_raster, window_size = 10)
dens_raster
plot(dens_raster)
```

---

create_grid *Create a grid of square-shaped windows*

Description

Create a grid of square-shaped windows

Usage

```
create_grid(x, size, shift = NULL)
```

Arguments

x	A RasterLayer/RasterStack/RasterBrick
size	Expressed in the numbers of cells, is a length of the side of a square-shaped block of cells. It defines the extent of a local pattern. If `size=NULL` calculations are perfomed for the whole area
shift	Defines the shift between adjacent squares of cells along with the N-S and W-E directions. It describes the density (resolution) of the output grid. The resolution of the output map will be reduced to the original resolution multiplied by the shift. If shift=size the input map will be divided into a grid of non-overlapping square windows. Each square window defines the extent of a local pattern. If shift < size - results in the grid of overlapping square windows.

Value

An sf polygon object

Examples

```
x = create_realizations(race_raster, 1)
y = create_grid(x, size = 10)
y
```

---

create_realizations *Create Realizations*

Description

It constructs a high-resolution grid (a racial landscape) in which each cell contains only inhabitants of a single race. Realization is constructed based on race-specific grids. Racial composition at each cell is translated to probabilities of drawing a person of a specific race from a cell. Thus, the race label of a cell is a random variable. To obtain a stochastic realization of racial landscape, we use the cell's race probabilities and a random number generator to randomly assign specific race label to each cell (Monte Carlo procedure).

Usage

```
create_realizations(x, n)
```

Arguments

x	RasterStack with race-specific population densies assign to each cell
n	A number of realizations

Value

A RasterStack object containing n realizations. Single race label in a racial landscape is assigned based on the order of race-specific grids in RasterStack with input data (For example, the race_raster object has five layers named: asian, black, hispanic, other, white. The race labels in racial landscape raster will be 1 - asian, 2- black, 3 - hispanic, 4 - other, 5 - white).

Examples

```
library(raster)
real = create_realizations(race_raster, 10)
plot(real)
```

---

plot_realization   *Plot a Realization*

Description

Displays realization taking into account also subpopulation density.

Usage

```
plot_realization(x, y, hex, ...)
```

Arguments

x	A RasterLayer or a RasterStack/RasterBrick with one layer. Each value should correspond to a layer in y.
y	A RasterStack/RasterBrick with race-specific population densities
hex	A character vector with colors specified in hexadecimal format. Each color should correspond to a layer in y and value in x.
...	Additional arguments as for raster::plotRGB()

Examples

```
library(raster)
hex_colors = c("#F16667", "#6EBE44", "#7E69AF", "#C77213","#F8DF1D")
realization = create_realizations(race_raster, 1)
plot(race_raster)
plot(realization)

plot_realization(realization, race_raster, hex = hex_colors)
```

---

pop_vector   *An sf object*

Description

It is an sf POLYGON object with census block-level data. It consists of 7 variables: GISJOIN - block ID, ASIAN, BLACK, HISPANIC, OTHER, WHITE - number of people of given race/ethnicity in each block

Usage

```
pop_vector
```

Format

An sf object

---

quanfity_raceland   *Quantify a racial landscape*

Description

This function is a wrapper of several steps (functions) implemented in the raceland package: `create_realizations()`, `create_densities()`, `calculate_metrics()`, and `create_grid()`.

Usage

```
quanfity_raceland(
  x,
  n,
  window_size,
  neighbourhood = 4,
  fun,
  size = NULL,
  na_action = "replace",
  base = "log2",
  ordered = TRUE,
  threshold = 0.5
)
```

Arguments

x	RasterStack with race-specific population densities assign to each cell
n	A number of realizations
window_size	Size, expressed in the number of cells, of a square-shaped local window for which local densities will be calculated; it is recommended to use the small window_size, i.e., 10
neighbourhood	The number of directions in which cell adjacencies are considered as neighbours: 4 (rook's case), 8 (queen's case). The default is 4.
fun	Function to calculate values from adjacent cells to contribute to exposure matrix, "mean" - calculate average values of local population densities from adjacent cells, "geometric_mean" - calculate geometric mean values of local population densities from adjacent cells, or "focal" assign value from the focal cell
size	Expressed in the numbers of cells, is a length of the side of a square-shaped block of cells. It defines the extent of a local pattern. If size=NULL calculations are performed for a whole area
na_action	Decides on how to behave in the presence of missing values in w. Possible options are "replace", "omit", "keep". The default, "replace", replaces missing values with 0, "omit" does not use cells with missing values, and "keep" keeps missing values.
base	The unit in which entropy is measured. The default is "log2", which compute entropy in "bits". "log" and "log10" can be also used
ordered	The type of pairs considered. Either ordered (TRUE) or unordered (FALSE). The default is TRUE
threshold	The share of NA cells to allow metrics calculation in a square-shaped window

Value

An sf polygon object with five columns - row and col allowing for identification of each square polygon, ent - entropy measuring racial diversity, mutinf - mutual information, which is associated with measuring racial segregation, and geometry containing spatial geometries.

Examples

```
library(raster)
rl = quanfity_raceland(race_raster, n = 10, window_size = 10,
 neighbourhood = 4, fun = "mean", size = 20)
```

---

race_raster	*A RasterStack*

Description

A RasterStack covering an area of 60x60 cells. RasterStack contains 5 layers - a high resolution (30m) race-specific grids with values of subpopulation densities for Asian, Black, Hispanic, other and Whites

Usage

```
race_raster
```

Format

A RasterLayer

---

zones_to_raster *Convert zones to rasters*

Description

Convert zones to rasters

Usage

```
zones_to_raster(v, resolution, variables, ...)
```

Arguments

v	An sf object (POLYGON or MULTIPOLYGON)
resolution	A numeric vector of length 1 or 2 to set the resolution
variables	A character vector with columns names from v. The values from these columns will be (1) rasterized and (2) recalculated to densities. Each column will be represented as an layer in the output RasterStack
...	Additional arguments as for [fasterize::fasterize()](#)

Value

a RasterStack

Examples

```
library(sf)
library(raster)
plot(pop_vector)
popdens_raster = zones_to_raster(pop_vector, resolution = 30,
                          variables = c("ASIAN", "BLACK", "HISPANIC", "OTHER", "WHITE"))
plot(popdens_raster)
```

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